REMARKS

Entry of the present amendment under Rule 116 and reconsideration of the above-identified patent application, as amended, is respectfully requested. The present amendment is responsive to the Office Action mailed April 3, 2002. A petition for an extension of time in which to respond to the Office Action accompanies this amendment.

Claims 16-26 are pending in the application.

Support For Claim Amendments

Independent claims 16, 17, 20 and 21 have been amended to specify that the semiconductor device is --to be mounted on a substrate by flip chip bonding--.

This is supported in the specification, e.g., at page 2, lines 24-28 and page 6, lines 25-26.

New matter is not being presented by the present amendment.

Title Of The Invention

The Office Action objected to the title of the invention as not being descriptive. In response to this objection, the original title has been canceled by the present amendment and replaced by the title suggested by the Office Action.

In view of the new title of the invention, it is respectfully requested that the objection to the title of the invention be withdrawn.

§103

Claims 16-18, 20-22, 25 and 26 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,940,181 to Juskey, Jr. et al.

Claims 19, 23 and 24 were rejected under 35 U.S.C. §103(a) as being unpatentable over Juskey, Jr. et al. in view of Japan No. 4-65130.

These rejections are respectfully traversed.

Patentability

The present invention relates to a process for producing a semiconductor device (chip) to be bonded to a substrate by flip chip bonding. In the flip chip bonding, electrodes of a chip are directly bonded to electrodes provided on a substrate through a bump. The present invention is particularly directed to the formation of such a bump.

Juskey, Jr. et al. (U.S. 4,940,181), cited by the Office Action, relates to the bonding of bumps on a chip to a printed-circuit board. The present invention relates to the bonding of balls (bump material) to electrodes of a chip. The bonded members are entirely different between Juskey and the present invention. Juskey neither discloses nor suggests the present invention.

Okuyama, JP 4-65130 A, is directed to an insulation substrate. The present invention is directed to a flip chip bonding process using a semiconductor chip (IC chip) provided with bumps.

Insulation substrates have a very uneven surface compared with IC chips, and have limitations on its use for the formation of patterns of small pitch. For this reason, solder balls used in the insulation substrates have a size (diameter) of the order of 0.3 millimeter at the lowest. In contrast, the semiconductor device in the present invention uses solder balls having a size of 0.1 millimeter or smaller. Bumps used in flip chip bonding are conventionally formed by evaporation or plating, and processes, other than the process of the present invention, do not use balls of the order of 0.1 millimeter.

In Okuyama, electrodes on the insulation substrate are formed by plating Ni or Au on a base ofn Cu foil. In the IC chip of the application, Ti, W, Cr, Cu, Ni, Au or the like is deposited, as an under bump metal (UBM), on an electrode based on A1 or an A1 alloy, and a solder bump is formed on the UBM.

In the case of insulation substrates as described in Okuyama, solder balls are mounted together on several substrates, at a number of the order of from several tens to several thousands. In contrast, the process of the present invention can be applied to a chip to a wafer in which a large number of chips are included, and in the latter case, solder balls can be mounted together on the wafer at a number of the order of several hundred thousands. Thus, the present invention is superior in productivity to Okuyama.

As such, neither Juskey nor the combination of Juskey with Okuyama discloses or suggests the present invention.

It is therefore submitted that amended independent claims 16, 17, 20 and 21, and all claims dependent thereon, are patentable over Juskey, Jr. alone or Juskey, Jr. in view of Okuyama.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

The following is a marked version of amended independent claims 16, 17, 20 and 21.

--16. (Amended) A process for producing a semiconductor device to be mounted on a substrate by flip chip bonding comprising electrodes formed on a semiconductor chip, and bumps each consisting of a spherically formed metal ball having a given size, and adhesive bonded to the electrodes (8) for the attachment of the bumps, wherein each electrode (8) includes a layer of an electrode material (5) and at least one layer (6, 7) laminated to the layer of the electrode material (5) to avoid deterioration of bonding such that the at least one layer (6, 7) has peripheral dimensions substantially the same as or larger than those of the electrode material (5); said process comprising:

adhesive bonding the metal balls to the electrodes with a flux.--

--17. (Amended) A process for producing a semiconductor device to be mounted on a substrate by flip chip bonding comprising electrodes formed on a semiconductor chip, and bumps each consisting of a spherically formed metal ball having a given size, and adhesive bonded to the electrodes (8) for the attachment of the bumps, wherein each electrode (8) includes a layer of an electrode material (5) and at least one layer (6, 7) laminated to the layer of the electrode material (5) to avoid deterioration of bonding such that at least one of the at least one layer (6, 7) has a

thickness which is smaller than that of the electrode material (5) and the at least one layer (6, 7) has peripheral dimensions substantially the same as or larger than those of the electrode material (5); said process comprising:

adhesive bonding the metal balls to the electrodes with a flux.--

--20. (Amended) A process for producing a semiconductor device <u>to be mounted on a substrate by flip chip bonding</u> comprising electrodes formed on a semiconductor chip, and bumps each consisting of a spherically formed metal ball having a given size, and adhesive bonded to the electrodes (8) for the attachment of the bumps, wherein each electrode (8) includes a layer of an electrode material (5) and at least one layer (6, 7) laminated to the layer of the electrode material (5) to avoid deterioration of bonding such that the at least one layer (6, 7) has peripheral dimensions substantially the same as or larger than those of the electrode material (5); said process comprising:

adhesive bonding the metal balls, each metal ball being spherically formed and having the given size, to the electrodes; and

reflowing the metal balls.--

--21. (Amended) A process for producing a semiconductor device <u>to be mounted on a substrate by flip chip bonding</u> comprising electrodes formed on a semiconductor chip, and bumps each consisting of a spherically formed metal ball having a given size, and adhesive bonded to the

electrodes (8) for the attachment of the bumps, wherein each electrode (8) includes a layer of an electrode material (5) and at least one layer (6, 7) laminated to the layer of the electrode material (5) to avoid deterioration of bonding such that at least one of the at least one layer (6, 7) has a thickness which is smaller than that of the electrode material (5) and the at least one layer (6, 7) has peripheral dimensions substantially the same as or larger than those of the electrode material (5); said process comprising:

adhesive bonding the metal balls, each metal ball being spherically formed and having the given size, to the electrodes;

reflowing the metal balls.--

The following is a marked version of the amended title of the invention:

<u>METHOD FOR FABRICATING A</u> SEMICONDUCTOR DEVICE PROVIDED WITH LOW MELTING POINT METAL BUMPS [AND PROCESS FOR PRODUCING SAME].

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the present amendment be entered and the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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